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PATENT



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : Brown et al.
Serial No. : 08/621,631
Filed : March 26, 1996
For : Recovery of Metal Values
Art Unit : 3641
Examiner : Miller, E

Assistant Commissioner of Patents
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APPEAL BRIEF

Sir:

This is an Appeal Brief filed under 37 C.F.R. §1.192 in connection with the final rejection of claims 3 and 10-22 in the Final Office action mailed November 6, 2001. Each of the topics required by 37 C.F.R. §1.192 is presented herewith and is labeled appropriately.

Real Party in Interest

The real party in interest in the present application is the assignee, Cabot Corporation, 75 State Street, Boston, Massachusetts 02109 (hereinafter "Appellant").

Related Appeals and Interferences

The Appellant and the Appellant's legal representative know of no related appeals or interferences that will directly affect, will be directly affected by, or have a bearing on the Board's decision in this appeal.

Status of Claims

Claim 3 and 10-22 stand finally rejected and are the substance of this appeal. This appeal concerns a Continued Prosecution Application filed on November 30, 1999. Claims 1, 2 and 4-9 were canceled by the Appellant during the prosecution of the parent application. Claims 3 and 10-22 were rejected in a Final Office Action mailed November 6, 2001. The final rejection of claims 3 and 10-22 (shown in appendix) is appealed.

Status of Amendments

Applicant did not seek to amend the application after final rejection.

Summary of the Invention

The present invention provides processes for separation and recovery of metal values, such as scandium metal values, from metal containing materials such as ores, ore residues and slags which include the metal values. (Specification, page 1, line 38 to page 2, line 3) The processes are advantageous for selectively recovering metal values from depleted fluoridated solids remaining after the conventional processing of ores, concentrates or slags. Particularly for use in extracting and recovering radioactive metal values from tantalum and niobium containing materials such as ores, ore residues and slags. (Specification page 1, lines 4-7)

The production of many commercially valuable metals, or metal compounds, from mineral ores includes a process step of digesting the ore with a mineral acid such as hydrofluoric acid. The digesting step is utilized to convert metal species in the mineral ore to metal species which are soluble in aqueous systems so that the metal values may be separated out by selective extractions or the like. (Specification page 1, lines 10-15)

In a typical process, mineral ore concentrates containing tantalum and niobium are conventionally decomposed with hydrofluoric acid (HF) or mixtures of hydrofluoric acid and sulfuric acid (HF/H₂SO₄). The tantalum and niobium

heptafluoro complexes formed are then purified by solvent extraction and separated. (Specification page 1, lines 16-20)

In a conventional process for producing tantalum pentoxide (Ta_2O_5), the tantalum fraction from the ore decomposition is stripped into the aqueous phase and tantalum pentoxide is precipitated using ammonia and recovered by filtration. Niobium pentoxide may be produced in a similar fashion. (Specification page 1, lines 21-25)

Commercial processing of ores and slags, for example by the processes outlined above, results in ore residues having concentrated levels of metal values not extracted in, or separated by, the processing steps. In particular, ore residues from commercial processes typically have concentrated levels of radioactive metal values. (Specification page 1, line 34 to page 2, line 2)

The present invention provides a process for selectively extracting metal values from a starting material which includes one or more solubilizable metal values. The first step is separating and removing fluorine values from the starting material. Then leaching the remaining material to solubilize metal values contained in the remaining material and generate an aqueous solution comprising the solubilized metal values, and extracting a solubilized metal value from said aqueous solution. (Specification page 2, lines 9-16)

The invention is particularly directed toward the selective extraction of metal values, including, uranium, thorium, scandium and/or zirconium, from metal containing materials. As used herein the term "metal containing materials" includes naturally occurring ores, ore residues and/or slags which contain metal values. The process is particularly well suited to extracting metal and recovering metal values from tantalum/niobium production process ore residues. (Specification page 2, lines 17-23)

The present invention is advantageous for a number of reasons. For example, a process of the present invention may be utilized to selectively extract and recover commercially valuable metal elements from metal containing materials.

(Specification page 2, lines 25-27) Additionally, a process of the present invention may be utilized to selectively extract a radioactive element from a metal containing starting material thereby reducing the radioactivity of the starting material.
(Specification page 2, lines 28-31)

Issues

The Examiner finally rejected claim 10 under 35 U.S.C. § 102(b or e) as anticipated by or in the alternative, under 35 U.S.C. § 103 as obvious over each of “Scandium Recovery From a Tantalum Waste Residue: A Status Report” by D.D. Harbuck and G.R. Palmer, U.S. Bureau of Mines (1991) (“Harbuck”) and U.S. Patent No. 5,531,970 to Carlson (“Carlson ‘970”). The Examiner also rejected claims 3 and 10-22 under 35 U.S.C. § 103(a) as being unpatentable over Carlson ‘970. The issues presented for consideration in this appeal are:

1. Whether the Examiner erred in rejecting claim 10 under 35 U.S.C. § 102(b or e) as anticipated by or in the alternative, under 35 U.S.C. § 103 as obvious over each Harbuck and Carlson ‘970.
2. Whether the Examiner erred in rejecting claims 3 and 10-22 under 35 U.S.C. § 103(a) as being unpatentable over Carlson ‘970.

Grouping of Claims

For the purposes of this appeal, claims 10-13 and 15-20 stand and fall together as a group, and claims 14, 21, 3 and 22 stand and fall together as a group.

Argument

Issue 1: Whether the Examiner erred in rejecting claim 10 under 35 U.S.C. § 102(b or e) as anticipated by or in the alternative, under 35 U.S.C. § 103 as obvious over each Harbuck and the Carlson '970.

A claimed invention is not patentable as anticipated if “(b) the invention was patented or described in a printed publication in this or a foreign country ... more than one year prior to the date of the application for patent in the United States, or ... (e) the invention was described in a patent granted on an application for another filed in the United States before the invention thereof by the applicant for patent” 35 U.S.C. § 102 (b and e). Anticipation requires the claimed process, including each step thereof, be described or embodied, either expressly or inherently, in a single reference. *Glaverbel S.A. v. Northlake Mkt'g & Supp., Inc.*, 33 USPQ2d 1496, 45 F.3d 1550 (Fed. Cir. 1995).

A claimed invention is not patentable as obvious “if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.” 35 U.S.C. § 103(a) (1994). The ultimate decision on obviousness is a “legal conclusion based on underlying factual inquiries including: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness.” *In re Huang*, 40 USPQ2d 1685, 1687-88, 100 F.3d 135, 138 (Fed. Cir. 1996) (citing *Graham v. John Deere Co.*, 148 USPQ 459, 467, 383 U.S. 1, 17-18 (1966)).

In the Final Office Action mailed November 6, 2001, the Examiner stated “[i]n Carlson '970, note ‘Example E’, col. 15-16, where scandium is recovered by

extraction with DEHPA and then stripped with 2M NaOH, the scandium extraction being quantitative. This is from the earlier process of "Example B", col. 10, which may be from a sulfuric/boric acid leach, line 42 or via sulfuric acid alone, line 52. In Harbuck et al., pages 109-110, strong sulfuric acid worked well, as did extraction with DEHPA at pages 114-115, and stripping with NaOH on page 116, for example." (Final Office Action page 2, para. 2) The Examiner also stated "[t]o the Extent necessary, variation of parameters would have been obvious to one of ordinary skill in the art. It is well settled that optimizing a result effective variable is well within the expected ability of a person of ordinary skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980), *In re Aller*, 220 F.2s 454, 105 USPQ 233 (CCPA 1955). (Final Office Action page 2, para 2)

In rejecting claim 10 the Examiner refers Applicants to Example E, col. 15-16 of Carlson '970 in which uranium and thorium are extracted and scandium and zirconium recovered (Final Office Action, page 2, para. 2). However, for a proper Section 102(b or e) rejection, a prior art reference must contain all the elements of the claimed invention to be said to properly "anticipate" the claimed invention. Lewmar Marine Inc. v. Barient Inc., 3 U.S.P.Q.2d 1766 (Fed. Cir. 1987). Carlson '970 does not teach or suggest each of the claimed limitations of the present invention. In fact, quite opposite, Carlson '970 describes a process for the concurrent separation of uranium or thorium values from values of at least one other metal such as tantalum, niobium, scandium, zirconium, titanium or magnesium where such values are contained in a "difficult soluble matrix" of highly fluorinated feed materials, such as uranium or thorium bearing ores (see Abstract, lines 1-5; and col. 2, lines 56-61, describing "other typical metals" present in such highly fluorinated feed materials).

The present invention provides a method for the selective separation of selected materials. Scandium, for instance, is known to be soluble in both H₂SO₄ and HCl solutions; however, coprecipitation of other associated elements poses a significant problem. Rather than providing a method for obviating this problem, Carlson '970 specifically provides for the "substantially concurrent release" of

fluorine and radionuclitide values, particularly uranium and thorium (col. 3, lines 61-62). Accordingly, Carlson '970 does not anticipate the presently claimed subject matter. As such, Applicants respectfully assert that the rejection of claims 1 and 10 under 35 U.S.C. 102(b or e) is improper and should be withdrawn.

With respect to the rejection under 35 U.S.C. § 103(a) in view of Carlson '970 taken independently, Applicants urge that a proper Section 103 rejection requires evidence that the prior art is such that the skilled artisan would be motivated to combine the claimed elements in a manner to result in the claimed invention. The Carlson '970 reference describes a process for the simultaneous extraction of multiple metal values. Thus, the Carlson '970 reference actually teaches away from the Applicants' invention. One skilled in the art reviewing the Carlson '970 reference would not expect the Carlson '970 process to permit the selective extraction of a single metal value, such as scandium, as in the present invention. In Carlson '970, uranium and thorium are chemically separated from scandium and zirconium, which remain in the digest liquor even following three sequential extractions (col. 17, lines 7-10). Thus, it is respectfully asserted that the Carlson '970 reference does not anticipate or render obvious the present invention.

Harbuck presents a general overview regarding procedures for separating scandium and zirconium from a tantalum-niobium waste material. The Examiner cites pages 109-110, 114-115 and 116 of Harbuck as, in the Examiners opinion, teaching the extraction of scandium with "strong sulfuric acid", "DEHPA" and "NaOH" respectively. (Final Office Action page 2, para. 2)

Harbuck, however, is deficient to anticipate claim 10. Harbuck fails to disclose a process for selectively extracting scandium from the aqueous solution. The end product of the Harbuck process is a precipitate comprising scandium and zirconium. (Harbuck page 116, Table VIII) Harbuck then suggests further processing of the precipitate, ostensibly to recover and purify the scandium.

Applicants maintain that the step of selectively extracting scandium from the aqueous solution is more than merely "optimizing a result effective variable". One

feature of the Applicant's invention is the usefulness of the process in selectively extracting metal elements from metal containing materials. (Specification page 2, lines 29-31) Harbuck does not disclose such a procedure, nor is such a procedure obvious to one skilled in the art.

For the foregoing reasons, Harbuck fails to anticipate, or render obvious, claim 10.

Issue 2: **Whether the Examiner erred in rejecting claims 3 and 10-22 under 35 U.S.C. § 103(a) as being unpatentable over the '790 patent?**

A claimed invention is not patentable "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. § 103(a) (1994). The ultimate decision on obviousness is a "legal conclusion based on underlying factual inquiries including: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness." *In re Huang*, 40 USPQ2d 1685, 1687-88, 100 F.3d 135, 138 (Fed. Cir. 1996) (citing *Graham v. John Deere Co.*, 148 USPQ 459, 467, 383 U.S. 1, 17-18 (1966)).

To establish a *prima facie* case for obviousness under 35 U.S.C. § 103 (a), an Examiner must meet three basic criteria. "First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations." *Manual of Patent Examining Procedure* § 2143. "In determining the propriety of the Patent Office case for obviousness in the first

instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination, or other modification.” *In re Linter*, 173 USPQ 560, 562, 458 F.2d 1013, 1016 (CCPA 1972). As will be discussed below, Appellant submits that a person of ordinary skill in the art would not be led or motivated to modify the disclosures in the cited references in order to reach the invention claimed in the present application.

Claims 3 and 10-22 of the present invention provide a process for selectively extracting metal values from a starting material. The source material is leached in an acid solution to remove any flouring values and solubilize the scandium and other metal values. The solution is then contacted with an aqueous phase to remove the scandium values to the aqueous phase. This aqueous phase is then contacted with an organic medium which produces an organic phase containing scandium and an aqueous raffinate phase. The organic phase is then contacted with a scandium stripping agent to selectively strip scandium from the organic phase.

As noted above, in the Final Office Action mailed November 6, 2001, the Examiner stated “Eventual recovery of scandium, and organo-phosphate extraction is taught in “Example E” … [i]n any event, variation of the teachings of plural, sequential stages and other parameters would have been obvious … as to optimizing result effective variables.” (Final Office Action page 3) The Examiner further stated “[i]t is not clear from the arguments, comparing the recited claim limitations to the teachings of the prior art, what unexpected results or other factors are being relied upon to overcome the *prima facie* case made.” (Final Office Action page 3)

Carlson ‘970 discloses a process for separating uranium or thorium from at least one other metal such as tantalum, niobium, scandium, zirconium, titanium or magnesium wherein all of the values are contained in a difficult soluble matrix of highly fluorinated feed materials. The feed materials are first contacted with an acidic aqueous digest medium to solubilize the metal values. (Specification col. 5, lines 30-41) Any remaining solids containing tantalum or niobium are removed from the

solution to provide a digest liquor. (Specification, col. 5, lines 46-50) The liquor is then contacted with an organic phase to remove the majority of the uranium and thorium. (Specification col. 5, lines 54-56) Finally the organic phase containing uranium and thorium is separated from the substantially non-radioactive raffinate. (Specification col. 5, lines 57-58)

Specifically, in Example E of Carlson '970 a process is described for extracting uranium and thorium from the process liquor and the recovery of scandium and zirconium. (Specification col. 15, lines 65-67) After the acid digest process described above, the remaining liquor is subjected to a four-stage counter current extraction, using an organic extractant. (Specification col. 16, lines 4-6) Following the extraction the organic phase is contacted with NaOH to strip metal values from the organic phase. (Specification col. 16, lines 9-11) These metal values comprised scandium and zirconium and may then be disposed or treated further to recover metal values. (Specification col. 16, lines 19-28 and 39-40) Thus, Carlson '970 does not provide a process for selectively extracting scandium from a feed material, rather, Carlson '970 describes a process for the concurrent separation of uranium or thorium values from at least one other metal such as tantalum, niobium, scandium, zirconium, titanium or magnesium. (see Abstract and col. 2, lines 59-62)

Applicants urge that a proper rejection under 35 U.S.C. §103 requires evidence that the prior art is such that the skilled artisan would be motivated to combine the claimed elements in a manner to result in the claimed invention. Carlson '970, as described above, relates to a process for the extraction of several metal values from a starting material. One skilled in the art would not expect the process of Carlson '970 could be used to selectively extract one metal value, such as scandium, as in the present invention. In Carlson '970 a process is provided which separates uranium and thorium from scandium and zirconium, which remain in the digest liquor. Thus, it is respectfully asserted that Carlson '970 does not render obvious claims 3 and 10-22 of the present invention.

Conclusion

In view of the foregoing, it is submitted that the rejection of Claims 3 and 10-22 are improper and should not be sustained. Therefore, a reversal of the Final Rejection of the Examiner is respectfully requested.

This brief is being filed in triplicate.

Respectfully submitted,

Date: 10/7/02

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APPENDIX – Claims

3. The process of claim 21 wherein the step d) of leaching the sulfated material further comprises:

d1) reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate said aqueous solution comprising the one or more other solubilized metal values; and

d2) filtering said aqueous solution comprising the one or more other solubilized metal values to separate remaining material solids from said aqueous solution.

Claim 10. A process for selectively extracting scandium values from a source material which includes solubilizable scandium values, the process comprising the steps of:

- a) leaching the source material to solubilize scandium values contained in the source material and generate an aqueous solution comprising said solubilized scandium values and a solid phase at least partially depleted in scandium; and
- b) selectively extracting a scandium value from said aqueous solution.

11. The process of claim 10 wherein the source material further comprises fluorine, tantalum and/or niobium and step a) further comprises the steps of:

a1) reacting the source material with a solution of a first mineral acid for a period of time, and under temperature and pressure conditions sufficient, to solubilize at least a portion of tantalum and niobium from the starting material and create a solution comprising tantalum and niobium metal values and a solids residue comprising fluorine and scandium metal values, and at least partially depleted in tantalum and niobium metal values;

a2) separating and drying the solids residue

a3) reacting the solids residue with a second mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient, to

liberate hydrogen fluoride gas and to generate a sulfated material comprising scandium metal values and at least partially depleted in fluorine metal values; and

a4) leaching the sulfated material to solubilize scandium metal values contained in the sulfated material and generate said aqueous solution comprising scandium metal values and a solid phase at least partially depleted in scandium.

12. The process of claim 11 wherein the step a4) of leaching the sulfated material comprises the steps of:

a4a) reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate said aqueous solution comprising solubilized scandium metal values; and

a4b) filtering said aqueous solution comprising solubilized scandium metal values to separate remaining material solids from said aqueous solution.

13. The process of claim 12 wherein the step b) of selectively extracting a scandium metal value from said aqueous solution comprising solubilized scandium metal values comprises the steps of:

b1) contacting said aqueous solution comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;

b2) separating said organic phase from said raffinate phase;

b3) stripping scandium from said organic phase by contacting said organic phase with a scandium stripping agent, said scandium stripping forming a phase comprising scandium from said resultant organic phase and an aqueous phase comprising said scandium stripping agent and a final organic phase.

14. A process for selectively extracting scandium metal values from a source material comprising scandium, fluorine, tantalum and/or niobium metal values the process comprising the steps of:

- a) reacting the source material with a solution of a first mineral acid for a period of time, and under temperature and pressure conditions sufficient to solubilize tantalum and niobium into solution and thereby generate a solution comprising tantalum and/or niobium metal values, and a remaining material at least partially depleted in tantalum and/or niobium and comprising fluorine and/or scandium metal values;
- b) separating and drying the remaining material;
- c) reacting the remaining material with a second mineral acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material at least partially depleted in fluorine metal values and comprising scandium metal values;
- d) reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution comprising scandium metal values;
- e) filtering said aqueous solution comprising scandium metal values to separate remaining material solids from the aqueous solution;
- f) contacting said aqueous solution resulting from step e) comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution resulting from step e), thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;
- g) separating said organic phase from step f) comprising scandium metal values from said raffinate phase at least partially depleted in scandium metal values;
- h) stripping scandium metal values from said organic phase by contacting said organic phase from step g) with a scandium stripping agent, said stripping forming a scandium phase comprising scandium metal values from said organic

phase, an aqueous phase comprising said scandium stripping agent and a final organic phase comprising said diluent and said extractant.

15. A process for selectively extracting scandium metal values from a sulfated starting material which includes scandium metal values comprising the steps of:

- a) reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution comprising scandium metal values;
- b) filtering said aqueous solution comprising scandium metal values from step a) to separate material solids from the aqueous solution;
- c) contacting said aqueous solution from step b) comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;
- d) separating said organic phase comprising scandium metal values generated in step c) from said raffinate phase at least partially depleted scandium metal values;
- e) stripping scandium metal values from said organic phase by contacting said organic phase from step d) with a scandium stripping agent, said stripping forming a scandium phase comprising scandium metal values from said organic phase, an aqueous phase comprising said scandium stripping agent and a final organic phase comprising said diluent and said extractant.

16. The process of claim 10 wherein the source material in step a) is an ore residue further comprising fluorine, tantalum and/or niobium and step a) further comprises the steps of:

- a1) reacting the ore residue with a solution of a first mineral acid for a period of time, and under temperature and pressure conditions sufficient, to solubilize

at least a portion of tantalum and niobium from the source material and create a solution comprising tantalum and niobium metal values and a solids residue comprising fluorine and scandium metal values and at least partially depleted in tantalum and niobium metal values;

- a2) separating and drying the solids residue generated in step a1);
- a3) reacting the solids residue from step a2) with a second mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient, to liberate hydrogen fluorine gas and to generate a sulfated material comprising scandium metal values and at least partially depleted in fluorine metal values; and
- a4) and leaching the sulfated material to solubilize scandium metal values contained in the sulfated material and generate said aqueous solution comprising scandium metal values and a solid phase at least partially depleted in scandium metal values.

17. The process of claim 16 wherein the first mineral acid in step a1) comprises sulfuric acid.

18. The process of claim 17 wherein the step b) of extracting a scandium metal value from said aqueous solution comprises:

- b1) contacting said aqueous solution with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising scandium metal values and a raffinate at least partially depleted in scandium metal values; and

- b2) contacting said organic phase generated in step b1) with a scandium stripping agent to form a scandium phase comprising at least a portion of the scandium metal values present in said organic phase; an additional aqueous phase comprising said scandium stripping agent; and a final organic phase at least partially depleted in scandium metal values.

19. The process of claim 18 wherein the organic medium of step b1) comprises DEPHA (Di 2-ethylhexylphosphoric acid) as an extractant and an aliphatic non-soluble C9-c16 hydrocarbon as a diluent.

20. The process of claim 19 wherein the scandium stripping agent of step b2) comprises sodium hydroxide.

21. A process for selectively extracting a metal value from a source material which includes fluorine and one or more solubilizable metal values, the solubilizable metal values including tantalum or niobium metal values, the process comprising the steps of:

- a) reacting the source material with a solution of a first mineral acid for a period of time, and under temperature and pressure conditions sufficient, to solubilize at least a portion of the tantalum or niobium metal values from the source material;
- b) separating and drying the undissolved material;
- c) reacting the undissolved material from step b) with a second mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material;
- d) leaching the sulfated material from step c) to solubilize at least a portion of the metal values contained therein and generate an aqueous solution comprising said solubilized metal values and a solid phase at least partially depleted in the solubilized metal values; and
- e) selectively extracting a solubilized metal value from said aqueous solution.

22. A process for selectively extracting a scandium metal value from an ore residue from a tantalum production process which includes fluorine, scandium and

one or more additional solubilizable metal values, the additional solubilizable metal values include tantalum or niobium metal values, the process comprising the steps of:

- a) reacting the ore residue with a sulfuric acid solution to solubilize at least a portion of the tantalum or niobium metal values from the ore residue and produce an undissolved material;
- b) separating the undissolved material from step a);
- c) separating and removing fluorine values from the ore residue by reacting the undissolved material from step b) with sulfuric acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material;
- d) leaching the sulfated material from step c) in water to solubilize at least a portion of the scandium metal values contained therein and generate an aqueous solution comprising said solubilized scandium metal values and a solid phase at least partially depleted in the scandium solubilized metal values;
- e) selectively extracting solubilized scandium metal values from said aqueous solution generated in step d) by contacting said aqueous solution with a sodium hydroxide stripping agent to produce a solid phase comprising scandium metal values and separating the solid phase from the remaining aqueous solution; and
- f) drying and recovering the scandium metal values.